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(54) Location apparatus for a mobile object

(57) In order to locate the position of a mobile object such as a vehicle a receiver 5 measures the Doppler shift in a signal received from at least one transmitter 2, 3, 4 in the vicinity of the vehicle, and the velocity vector of the vehicle is also determined. By comparing the measured Doppler shift with the maximum Doppler shift possible for that particular vehicle speed, a bearing for the or each transmitter relative to the velocity vector of the vehicle is produced. In this way, the position of the vehicle can be identified, and existing radio transmittters may be used for this purpose.

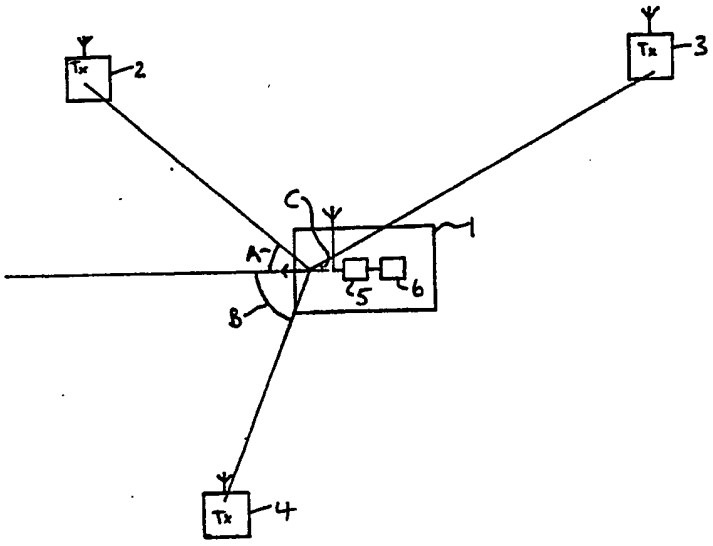

Fig 1

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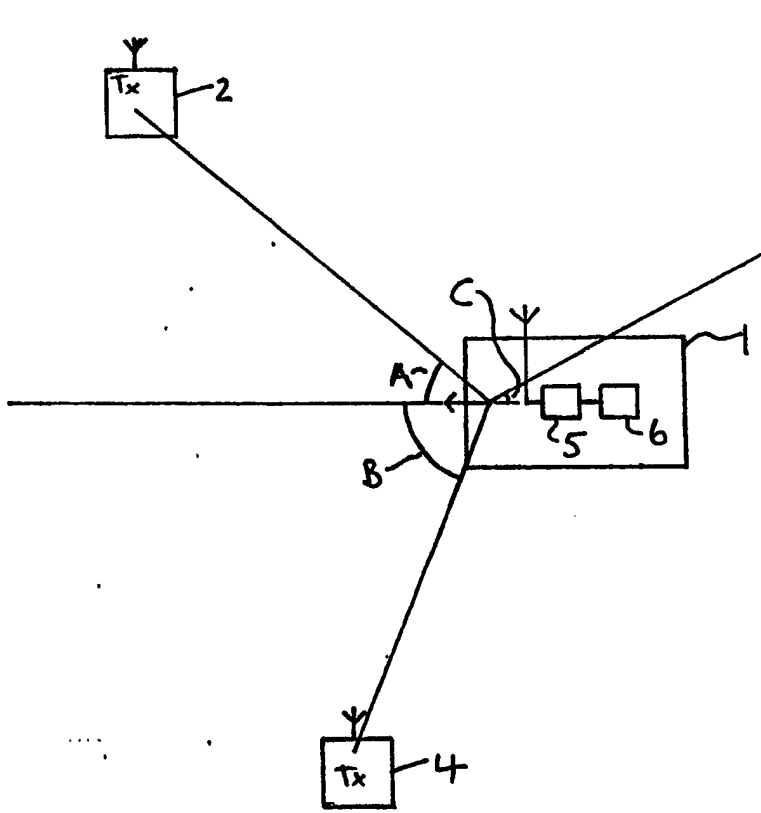

Fig 1

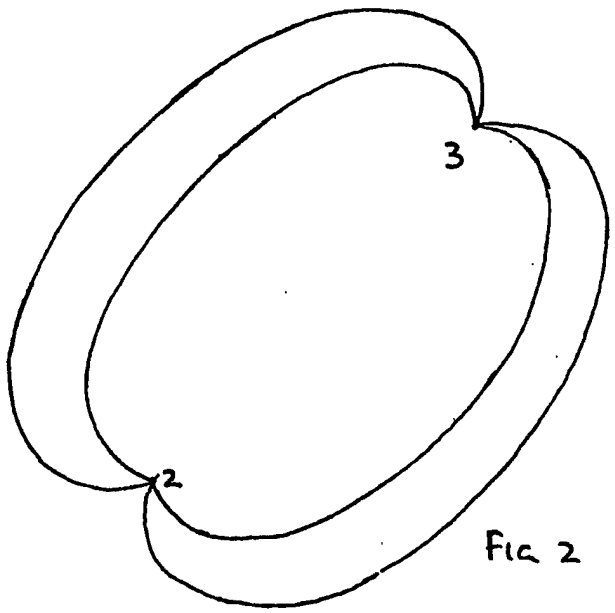

Fig 2

Location of The Position of a Mobile Object

This invention relates to the location of the position of a mobile object.

Various positioning systems have been proposed, including measurement of the change of the Doppler shift of a satellite relative to a ship, which enables the ship's position to be calculated knowing the track of the satellite and instantaneous positional information transmitted by it.

The invention provides location apparatus for a mobile object, comprising receivng means for connection to the mobile object for measuring a Doppler shift in a signal received from a radio transmitter having a known fixed location, and processing means for using the Doppler shift and a measurement of the velocity of the object to deduce information about the position of the object.

The need for infrastructure in the form of moving satellites is avoided since the normal motion of the object itself is used to produce the Doppler shift.

The invention also provides a method of location of a mobile object, comprising measuring the Doppler shift in a signal received at the object from a radio transmitter having a known fixed location, and using the Doppler shift and a measurement of the velocity of the object to deduce information about the position of the object.

Usually measurements from a single transmitter will

be insufficient to locate the position of the object completely, and the position will be determined by measuring signals received from at least two transmitters. Two transmitters would suffice in conjunction with a compass bearing measured at the object, but usually it would be necessary to calculate the position from a measurement of 3 transmitters.

For each transmitter, the Doppler shift may be calculated by comparison of frequency of the signal received at a particular velocity of the object with the frequency calculated, or stored in tables, corresponding to zero Doppler shift i.e. when the object is stationary. Alternatively, the Doppler shift could be calculated at two different velocities of the object, and the position deduced from the difference between the Doppler shifts and the corresponding difference between the velocities of the object.

The object may be a vehicle but could be a pack to be attached to a person or could be a water craft. In the case of a vehicle, the invention enables an operator of a fleet of vehicles eg. delivery vehicles, taxis or cabs, police cars, ambulances, buses, etc to be able to pin point the position of each vehicle on a map of the territory covered: at present such location can only be done by individual drivers phoning their locations in from time to time.

Advantageously, the receiving means and processing

means are such as to use signals from broadcast radio transmitters eg. commercial and public radio stations, T.V. stations, radio telephone base stations, or other fixed existing transmitters of radio waves. In this context, it is to be understood that any transmitters of electro-magnetic waves operating between ~~100~~ 50 KHz and 1THz (One Thousand GHz) are to be considered as radio transmitters. It will be apparent that the transmitter need not and usually will not have to be provided by the user of the location apparatus i.e. the apparatus of the invention is designed to exist with pre-exisiting infrastructure.

It is not necessary for the processing means to be physically positioned in the same unit as the receiving means. Thus, the location apparatus may be provided with a transmitter which can transmit sufficient information to a base station for the processing to be done at the base station.

Apparatus for and a method of locating the position of a mobile object, in accordance with the invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a schematic diagram of a vehicle incorporating the location apparatus; and

Figure 2 is a schematic diagram of the locus of points which subtend certain angles at two of the transmitters.

Referring to Figure 1, a vehicle 1 is shown

schematically in the vicinity of three radio transmitters 2, 3, 4. The vehicle has a receiver 5 and processing means 6, which has an input from the receiver 5 and from sensor 6 which senses the speed of rotation of a vehicle wheel, and hence provides a signal indicative of vehicle speed. Means is provided for the receiver 5, which is omni-directional, to identify the three most powerful radio transmitters in its vicinity at any one time, by measuring the signal strengths of a series of transmitting frequencies of transmitters of known locations stored in tables in a memory. When the vehicle is stationary, the receiver 5 measures to a high degree of accuracy and stores the frequencies of each of the three most powerful transmitters.

The vehicle then moves off from rest, a further measurement of the frequencies of each of the three transmitters is made, and the corresponding vehicle velocity is also measured. It will usually be found that the frequency values now measured are all slightly different from those measured when the vehicle was at rest, the difference being due to the Doppler effect.

If the vehicle happened to be travelling directly towards or away from a transmitter, the Doppler shift in frequency would be equal to that due to the velocity of approach or recession of the vehicle from the transmitter.

Of course, usually, the vehicle will be travelling

obliquely to a transmitter, and the actual measured Doppler shift will be less than the maximum possible Doppler shift for the respective vehicle velocity. The percentage of the maximum Doppler shift which the measured Doppler shift represents enables a bearing to be calculated between the velocity vector V of the vehicle and the transmitter. Thus, if the Doppler shift indicates that the vehicle is appraoching the transmitter, and that the measured shift is 90 percent of the maximum possible shift, then one will know that the angle between the velocity vector and the transmitter will be small, and if the measured Doppler shift is a small percentage of the maximum possible Doppler shift, the vehicle will be travelling almost transversely to the transmitter.

By comparing the measured Doppler shift with the maximum possible Doppler shift indicated by the vehicle velocity, the processing means 6 calculates a bearing A, B or C relative to the velocity vector of the vehicle, for each transmitter, utilising also the knowledge as to whether the vehicle is approaching or receding from the transmitter, (based on whether the shift is positive or negative). Knowing the three bearings, enables the position of the vehicle relative to the known positions of the transmitters to be calculated.

As an alternative to measuring the transmitter frequencies when the vehicle is stationary, the memory table may already contain a sufficiently accurate value

for one or more of the transmitter frequencies.

As a further alternative, two values of Doppler shift for each transmitter may be measured for two different vehicle velocities, the vehicle preferably travelling in a straight line, and the vehicle location may be deduced from the change of Doppler shift in conjunction with the change in vehicle velocity.

The processor may be arranged to compare the relative bearing of pairs of transmitters e.g. measurements might indicate that the vehicle was approaching transmitter 2, and that the transmitter was located 5 degrees away from the velocity vector on one side or the other. Measurements might also indicate that the vehicle was approaching transmitter 3, and that the transmitter was located 15 degrees away from the velocity vector on one side or the other. This would give four possible situations, either both transmitters would be to the left, or to the right of the velocity vector, subtending an angle of 10 degrees at the vehicle, or the transmitters may be on opposite sides of the velocity vector, in each case subtending an angle of 20 degrees at the vehicle. Thus, for each pair of transmitters, the locus of points on which the vehicle could lie will be one of four curves as illustrated in Figure 2. Loci for the other pairs of transmitters 3, 4 and 4, 2 may also be calculated, and the intersection will indicate the location of the vehicle.

The processing means may be housed on the vehicle, but may if desired be housed in a base station if the vehicle is in communication with such a base station.

The invention also encompasses using a satellite which transmits data about its position and whose orbit is known, in conjunction with apparatus for measuring its Doppler shift, in order to locate the position of an object. Also, the invention encompasses deducing the position of an object by using a mechanically or electronically rotated antenna and measuring the Doppler shift variation relative to a known fixed radio transmitter.

CLAIMS

1. Location apparatus for a mobile object, comprising receiving means for connection to the mobile object for measuring a Doppler shift in a signal received from a radio transmitter having a known fixed location, and, processing means for using the Doppler shift and a measurement of the velocity of the object to deduce information about the position of the receiving means.

2. Location apparatus as claimed in claim 1, in which the processing means is arranged to deduce positional information using a measurement of the velocity of the object and Doppler shifts from at least two radio transmitters having known fixed locations.

3. Location apparatus as claimed in claim 1 or claim 2, in which the receiving means is arranged to receive signals from broadcast radio transmitters.

4. Location apparatus as claimed in any one of claims 1 to 3, in which the processing means is arranged to deduce positional information using measured Doppler shifts at two different measured velocities of the radio signal from the or each transmitter.

5. Location apparatus substantially as herein described with reference to the accompanying drawings.

6. A method of location of a mobile object, comprising measuring the Doppler shift in a signal received at the object from a radio transmitter having a known fixed location, and using the Doppler shift and a measurement

of the velocity of the object to deduce information about the position of the object.

Further copies may be obtained from The Patent Office.